DOCUMENT RESUME

ED 097 416 CE 002 113

AUTHOR	Fortune, Jim C.
TITLE	Performance Test for Auto Mechanics: Appendix I. Final Report.
INSTITUTION	Massachusetts Univ., Amherst. Center for Occupational Education.
SPONS AGENCY	Massachusetts State Dept. of Education, Boston. Research Coordinating Unit for Occupational Education.; New York State Education Dept., Albany. New York Research Coordinating Unit.
PUB DATE	Jun 72
NOTE	76p.; For related documents see ED 060 218, ED 085 541, CE 002 111-117
EDRS PRICE	MF-$0.75 HC-$4.20 PLUS POSTAGE
DESCRIPTORS	*Auto Mechanics (Occupation); *Behavioral Objectives; *Criterion Referenced Tests; Educational Objectives; *Item Banks; *Performance Based Education; Test Construction; Trade and Industrial Education; Vocational Education
IDENTIFIERS	ESCOE; Massachusetts; New York

ABSTRACT

This is one of the outcomes of the work of the Massachusetts Evaluation Service Center for Occupational Education (ESCOE). Automobile mechanics was selected as a test development area because of the uniqueness of its curriculum, being controlled by the automobile manufacturers through competitive design and redesign of their products. Because of the differences in manufacturer specifications and the fact that the function of the mechanic is to repair or replace, not to create or produce, problems were created which had to be overcome in test development. With this in mind the document briefly discusses test unit materials, a description of the test chassis and optional units, and the test item bank used. Each of these test units on auto mechanics are divided into the following format for teacher use: (1) test item--the task to be done; (2) unit section--piece of test equipment on which the item is to be administered; (3) actual task--describes interactions which are to occur between tester and testee; (4) time--estimate of time required to complete the test task; (5) scoring--detailed criteria to be observed by the classroom teacher; (6) record--description of camera angles from which the completed task should be photographed for central scoring; and (7) record scoring--criteria instructions for the central scorer. (Author/BP)

ED 097416

FINAL REPORT

BEST COPY AVAILABLE

Evaluation Service Center for Occupational Education

APPENDIX I:

Performance Test For Auto Mechanics

U.S. DEPARTMENT OF HEALTH
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

by

Jim C. Fortune

Submitted To:

Commonwealth of Massachusetts
Department of Education
Division of Occupational Education
Research Coordinating Unit
Boston, Massachusetts

State of New York
Department of Education
Bureau of Occupational Education
Research Coordinating Unit
Albany, New York

Evaluation Service Center for Occupational Education
Center for Occupational Education, School of Education
University of Massachusetts, Amherst

June 1972

This test is one of four tests published as separate appendices to the Final Report of the Evaluation Service Center for Occupational Education, Center for Occupational Education, School of Education, University of Massachusetts, Amherst, Massachusetts, June 1972.

CE 002 113

TABLE OF CONTENTS

	Page
Overview of Performance Test Development Project	iii
Introduction	1
Test Development	2
Test Unit Materials	5
Test Chassis	7
Optional Units	9
Brake Unit	10
Test Item Bank	11
Administration and Scoring Procedures	59
Field Review and Recommendations	61

BEST COPY AVAILABLE

OVERVIEW OF THE PERFORMANCE TEST DEVELOPMENT PROJECT

Background

The 1968 Amendment to the Federal Vocational-Technical Education Act mandated the development of state-wide evaluation systems for the administration and operation of federally supported vocational education. Parallel to this mandate the Research Coordinating Unit director for the Commonwealth of Massachusetts was in the process of completing some predesign activities for the development of a vocational-technical education management information system. By 1969 the predesign of this system had moved into the feasibility stages and specifications of the system were being developed.

At this stage of development New York State, which already had a fine centralized testing program, became interested in the philosophy espoused by the Massachusetts system and joined in the funding of a more intense feasibility test, which eventually became the source of the Performance Test Development Project. The Evaluation Service Center for Occupational Education (ESCOE) was funded in July 1971 and was housed in Amherst, Massachusetts, to test the feasibility of systems development based upon the principles of (1) local control and development of vocational curricula, (2) data-based feedback based upon tailored performance tests, and (3) curriculum description through terminal behavior objectives. The following report deals with a subcomponent of the ESCOE system which was designed to develop performance tests as software support for the ESCOE program.

Whats and Whys of Performance Testing

Performance testing is more a new reality as opposed to a new concept in educational testing. The concept grows out of the need felt by educators to

BEST COPY AVAILABLE

sample actual performances of trainees as opposed to merely measuring symptoms of desired (or intended) competencies through paper and pencil tests and then relying upon the predictive powers (i.e., previously established associations of paper and pencil test scores to some hypothetical or observed criterion of competency in performance) of the test to infer competency acquisition. This felt need has grown in part from the inability of standardized achievement tests to deal with the unique objectives of a specific educational program, in part from the reportedly low correlations between measured skills and on-the-job (or in-the-shop) performances, and in part from the lack of realism involved in the paper and pencil testing situation.

Hence the performance test can be conceived of as a criterion-referenced test, in that (1) it is objective or criterion-centered (in one-to-one correspondence with the extant component of a stated objective); (2) it seeks to ascertain a subject's possession of a specific competency rather than to complete a comparison of the subject's competency level to a previously measured norm group; and (3) it usually requires a dichotomous decision as to whether the competency has been demonstrated. The performance test can be construed to be a special case of the criterion-referenced test in that there is a definite attempt to establish fidelity between the sample observation of the performance test and the performance being sampled.

In the evaluation of instructional programs in vocational-technical education, the concept of performance testing is especially appropriate for several different reasons. First, performance tests can be hypothesized to produce more relevant and valid date concerning the instructional program output. Vocational program objectives tend to deal with competencies which require concurrent behavior changes across several domains of instructional objectives.

hence the accomplishment of a vocational objective may depend upon the development of a psychomotor skill, the mastery of a cognate process, the acquiring of some fundamental facts, and the development of a particular attitude. Unlike paper and pencil tests, which emphasize the measurement of the cognitive aspects of the performance or observations which emphasize process and action components, performance tests possess the potential to measure the mixture of behavior domains appearing in the desired performance. The performance test can therefore be argued to offer a valid means of measuring intended outcomes.

Second, performance tests produce product records which can be studied by teachers to diagnose the place in the instruction where a weakness may have occurred, aiding considerably their ability to analyze their instructional methods. Since the teacher can determine what aspects of the competency are missing, he can trace the point in his instruction where his objectives were not met. Also, since the product is concrete it can be kept longitudinally to analyze pupil growth at different stages of a multi-year program.

Third, the nature of the data produced by performance testing contains the flexibility demanded by the information needs of an evaluation system. The tests are constructed in one-to-one correspondence to stated objectives, thus enabling selection of test components from a data bank situation in such a manner as to tailor the testing to the measurement of a unique set of program objectives. Since the tests are objective specific, comparisons of small aspects of an instructional program are possible. Since the tests are criterion-referenced, skill attainment in a particular area of interest can be ascertained; hence output of instructional programs can be described relative to percentage of skill development.

Restraints on Test Development

The design of the performance tests had to take into account both the philsophical and the operational structure of ESCOE. At times both of these structures served as restraining and occasionally frustrating hurdles for the test development team.

The philosophical nature of ESCOE provided the foundation of principles which are believed to have caused the performance tests to be unique. Since the objectives were generated by each local school, several very similar objectives appeared for a single behavior within a subject. Dr. David Berliner, now with the Far West Laboratory for Educational Research and Development, invented a process to state these similar objectives into a synthesized form accompanied by item changes providing for the unique characteristics of each objective. Thus, if enough objectives from different schools were collected to represent the curricula, by synthesizing those objectives one could arrive at a statement of all desirable behaviors within one curriculum.

The raw objectives based upon the curricula of each of the participating schools were synthesized to identify the major behaviors within a curriculum area. Hence, if the process worked ideally within a curriculum area a linear set of behaviors was produced. The degree to which this process failed to produce such a linear array of behaviors comprised the first major restraint. If a singular listing of behaviors could not be gained. then singular test items could not be written.

A second philosophical principle which developed into a restraining factor was the decision to test only locally-maintained objectives within a specific program. This principle actually involved several implications for testing. First, a student would be tested only on the objectives maintained

BEST COPY AVAILABLE

by the curriculum he was receiving. Therefore, the test items had to be described in a form indicating one-to-one correspondence with the synthesized objectives so that the local teacher could select only those items maintained for his course. This selection pattern, however, did increase the logical assumption that the tests possessed high validity in regard to the courses for which they were designed to measure outcomes. Second, each item had to be independent in its ability to be administered, since previous or adjoining items would not necessarily be administered with it. This item independence served as a restraint to test development in that objectives could not be clustered into tasks involving several test items.

The third restraint involved both philosophical and operational aspects in that two forms of scoring were preferred by the two cooperating states. Philosophically, the state coordinators differed on the location of scoring; this disagreement became a restraint to test development in that the items developed had to be scorable both in the local school and at a central test center. Three forms of scoring meeting this restraint were adopted, with choice of scoring form depending upon the nature of the individual item. Two of the forms are based upon meeting the restraint with a single scoring process. The third form requires two different processes in order to meet the dual scoring restraint.

The scoring approaches requiring only one process are (1) the caliper or mechanically scored form and (2) the selection of correct response form. In the mechanically scored approach, several measured settings can be placed in a test scoring kit; the student or teacher records by label which of the settings fits the final product. A key of correct setting labels can then be referred to, producing a dichotomous score for the product in terms of size

tolerances. In the selection of correct response approach, correction keys can be applied directly to the students' responses. In both cases either a central office or an individual classroom teacher can use the keys.

The third scoring form is not as simple, since two types of scores are required to meet the dual-use restraint. This scoring form is necessitated by the many tasks in the vocational curriculum which require expert observer judgment for the determination of performance quality. The two types of scoring needed for these items are (1) structured criteria for observation, and (2) pictorial records (color-coded to facilitate central scoring). The structured criteria for observation communicate to the teacher what aspects of the product to check in order to judge the performance successful. These criteria would be used in class. In the pictorial scoring process, camera angles have been described which would allow Polaroid pictures to be taken as records of the finished product. Color-coding the criteria checks would enable observers in a central location to determine the quality of the performance.

Each of these three approaches provides a means through which credible and unbiased scores can be obtained. All of the processes can be scored by individual teachers and used within a classroom setting without the aid of a central scoring station. The fourth restraint to test development arises at this point, since it is impossible to arrive at an immediately usable set of norms through the current scoring system and the dichotomous item response without implementation of a program designed to gather enough data to norm the tests.

Two other restraints were present throughout the test development project, both operational in nature. First was the quality and quantity of the

behavioral objectives themselves. Few if any of the curriculum areas were fully described, and the tests developed are limited to described curriculum. In two test areas, more items were developed and the synthesization process was repeated in order to sharpen the synthesized objectives. In these cases much curriculum had been left undescribed and the fill-in process aided considerably in explaining the descriptions. However, complete and multiple sets of items were not available from each school; therefore the test items may be lacking in content validity in cases of consultant-written items, may be representative of several behaviors, and may hence be difficult to test or represent only a small segment of the previously unwritten curriculum.

The second operational restraint was that of time. Although the budget was small, the seriously close deadlines in development work made time an even greater restraint. Creativity is sometimes especially evasive under deadlines and within the constraints of administrative conflict. Still, the time dimensions were met in terms of design. Since schools were closed during the critical month of June, illustrations of some items of the tests could not be produced; therefore only plans, item descriptions, materials descriptions and administration instructions could be developed.

A final restraint can be observed in the language in which the proposal was written. First, several terms apparently changed in meaning or in relevance to the project once development began. One apparent change occurred in the description of sixteen tests for four areas. One test for each level of a curriculum area cannot be developed so as to be equally relevant to all schools. Since the schools maintain different objectives, different items must be assigned to each school, even on the same level. Hence a more appropriate process becomes the development of an item bank from which tailored

tests can be developed for each individual program. Second, the time constraints and the differences in nature of curriculum required different kinds of tryouts, making the language of the proposal seem sometimes inappropriate.

Purposes of the Test Development Project

The design of the test development project included not only the goal of producing tests as products but also the goal of establishing feasibility of the test development effort across a broad spectrum of vocational-occupational curricula. For this reason four different areas of vocational curricula were selected for test development. These four areas differed in hypothetical difficulty of test development. The areas chosen were machine shop, woodworking and carpentry, electronics, and automobile mechanics. The automobile mechanics area was hypothesized to be the most difficult since manufacturers determined the curriculum, which therefore differed across competing manufacturers.

The performance tests were hypothesized to be sufficiently flexible to fulfill many purposes of a comprehensive evaluation system. Because of their proximity to the desired outcomes, performance tests were hypothesized to serve as (1) student diagnostic and prerequisite instruments, (2) diagnostic instruments for the analysis of instruction, (3) criterion instruments, (4) measures of classroom achievement, and (5) program success indicators. Each of these uses has already been piloted to some extent.

The performance tests as developed have several application conveniences. First, since the test items are paralleled to synthesized objectives, computer selection of test items or "synob" comparison of items can be used as a methodology for tailoring tests to instruction. Second, since the conceptual frames of the tests can be described, each test has built-in potential up-

dating or extension by the classroom teacher.

Problems Encountered

Problems occurred from three viewpoints. First was the problem of lack of known direction, a handicap which often occurs in the area of development. Second was the problem of lack of perfection or completion of the objectives used as raw materials for the development of test items. Third was the problem of contending with dual scoring requirements and with several different kinds of program emphasis and structure.

The first problem has been emphasized recently with the development work done on criterion-referenced testing. From a conceptual point of view, the criteria previously used to determine the quality of norm-referenced tests can no longer be used for criterion-referenced tests. Since the measurement strategy of the criterion-referenced test and the performance test is to determine the possession of either a skill or the capability to carry out an activity or process, the degree to which the test differentiates between subjects taking the tests does nothing to indicate test quality. Unlike the norm-referenced test, in which measurement strategy is to distinguish between subjects, the performance test cannot be hypothesized to produce large differences across subjects nor can any specific level of difficulty be expected. Hence, average levels of difficulty and large differences between subjects do not indicate quality of the performance test.

In performance testing, some concepts of reliability still appear useful, while others appear to have lost their relevance. Reliability over time, or test-retest reliability, is still meaningful as long as the time between tests did not include opportunity for the subject to acquire the skill in question. Since performance tests are designed so that each item does not necessarily

refer to the same skill or activity, reliability indices dealing with homogeneity of the test no longer appear to be relevant criteria for test quality.

The degree to which the items of a performance test cover the skills of an area and approximate actual required performances operates in a similar relationship to the performance test as that of a prediction index to a norm-referenced test. This degree of similarity might be compared to the concept of fidelity so often used in the recording industry.

The second problem area involved the quality of the raw materials used. As should be expected, the synthesis process does not apply evenly to all areas and was not applied with the same consistency to each set of objectives. In the machine shop curriculum area, between 70 and 80 percent of the content was described by the objectives. These objectives possessed adequate depth across skill areas to enable the synthesis process to produce clear synthesized objectives describing unique performances. The creation of items parallel to the synthesized objectives and possessing the independence and flexibility required by the philosophy of the system was a straightforward process.

In the woodworking area, between 60 and 75 percent of the content was described. Unfortunately, the synthesizers of the raw objectives failed to produce synthesized objectives which dealt only with single performances. Instead, the raw objectives were synthesized by similar or related behaviors and the product of this process was a matrix of similar performances (rather than a single performance) with several form changes denoting differences in conditions and extents across schools. Since these products seemed usable, the decision was made to produce a matrix of test items generated in one-to-one correspondence to the performances included in each synthesized objective.

this decision was the source of some time lost due to the expanded number of test items which had to be written; however, this increase in items was accompanied by a large increase in test specificity, which increases the degree to which the performance test can be tailored to fit a given instructional program without any noticeable loss of efficiency of the item banking process.

Due to the variance of material and the limited scope of the objectives developed for the electronics curriculum area, a decision was made to rewrite many of the synthesized objectives. For more than one-half of the contract period two of the test development team members struggled to find a format within which the scope of the electronics curriculum could be described. By expanding the number of conditions it was found that classes of performance could be described by synthesized objectives. Hence, through considerable redesign and a small set of compromises of the synthesis process involving uniqueness of performances and allowance of performance form changes, subcollections of electronics objectives could be written which would allow test development along similar conceptual lines as those followed in the development of the machine shop test. Results of the test development effort again produced item banks, as in the two previous test areas, with the items possessing similar relationships to the synthesized objectives.

In the area of automobile mechanics, less than 50 percent of the content was described by the raw objectives. Many of the subdivisions of content were too sparse to allow for the development of synthesized objectives. In addition, the synthesis process applied seemed irregular across blocks and units. The level of abstraction of behaviors described by the raw objectives and the interdependence of the performances raise questions concerning the appropriateness of the synthesis process in this area. Certainly, the limited number

of usable synthesized objectives and the necessary revisions of the existing objectives made the decision to rewrite the objectives essential. Revision of the curriculum descriptions were made in relationship to the job orientation of the curriculum. Test items were written around standard mechanics tasks as described in the automobile mechanics curriculum. In some of these items, synthesized objectives are tested in a format which includes a cluster of the objectives provided by the ESCOE system. In other items, only parts of ESCOE-produced objectives are included in the new synthesized objectives being tested. Once a test item has been constructed, the process can be reversed so that system capability as achieved in the other three test areas can be gained. Because of their time-consuming nature, tasks in the curriculum such as disassembly or reassembly of a motor or transmission were not included as complete test items. Instead, either sample tasks extracted from the large unmanageable task or written or pictorial selection items were created to test these phases of the curriculum.

The third problem area encountered was the difficulty involved in the existence of two separate scoring requirements and in the time limitations of the test development project. It was not always possible to produce useful in-class scoring of the performance item and credible, objective centralized scoring of the performance through application of the same scoring process. Therefore some items are suspected to produce more useful scores in the classroom than in a central scoring situation, while the reverse is suspected of other items. Only time and study of the tests can alter or affirm these suspicions. It is unfortunate that systematic refinement of the woodworking, electronics, and automobile mechanics tests is not planned to occur along the same lines as those applied to the machine shop test.

The following report includes development and field testing procedures, item bank descriptions, recommended analysis procedures and uses for one of the four test areas briefly described above.

Introduction

Automobile mechanics was selected as a test development area because of the uniqueness of its curriculum. Unlike many of the vocational curriculum areas, the automobile mechanics curriculum is actually controlled by the automobile manufacturers through competitive production design and redesign of their products. For example, in a given year the braking system assembly design of any two automobiles produced by different manufacturers may vary significantly. This variance may involve different locations of individual components, variance in size or shape of these components, or differences due to special manufacturer's features built within the system. The brakes may require different sized brake shoes or different locations of brake shoe connection springs; or the difference may be in type of braking system used--disc brakes, power brakes, self-adjusting brakes, or standard brakes. Similar differences occur across all parts of the automobile.

These differences in manufacturer specifications usually occur within year and across models. Yet these differences represent only part of the problem in automobile mechanics, where automobiles ranging from four to five years old as well as newer models are commonplace on the road and in the shop. Ten-year-old and older models are used as second cars, producing not only differences across competitors and across models of various sizes and costs, but also differences across generations of the same automobile. Often these are the differences which appear most difficult to handle in curriculum development. Examples of generation changes can be seen in such recent changes as emission controls and bumper modifications.

In addition to the differences built into the raw materials with which

automobile mechanics must work, there is another unique aspect of the curriculum: the task of the mechanic is not to create or produce, but to repair or replace. Hence the mechanic must deal with a product already possessing shape and function. Something is wrong with the product and the mechanic must determine what is wrong, decide upon the most appropriate correction route, and make the necessary repairs or replacements. This set of operations builds into the curriculum such unique problems as location of malfunctioning automobiles upon which to teach or creation of basic models, closely simulating the automobile, to use as instructional models. The trouble-shooting and repair aspects of the curriculum make the conduct of any one task a multi-skill performance rather than a single skill performance. Therefore, many of the objectives become so related that some require the completion of prerequisite objectives before they can be attempted.

Test Development

The curriculum differences of the automobile mechanics area created problems which had to be overcome in test development. These problems at times slowed progress and at times forced the developer to deviate from normal procedures in order to overcome hurdles.

Automobile mechanics was selected as a test development area because of its anticipated difficulty. First attempts at test development followed the same lines along which the other tests were formulated, beginning with an analysis of the synthesized objectives. This beginning was not a fruitful as had been hoped, in that the synthesized objectives were not uniform in abstraction levels or in depth (number of replications of a task across

schools).

Perhaps some of the lack of progress was due to the anticipated difficulty; another factor may have been the feeling that a desirable test was already in existence in the field. Logistics was probably still another factor, because of the absence of appropriate equipment and procedures through which the test might be administered. In order to minimize the anticipated problems, a search of existing performance tests was made. The search included contact with the evaluation center at Ohio State University; contact with James Popham's behavioral objectives bank; review and contact with the work of Thomas Baldwin at the University of Illinois; and reviews of research literature, literature of companies making instructional materials for the automobile mechanics area, and literature of certification agencies. The review disclosed a very well-constructed multiple choice test used as the National Automotive Technicians' Certification Test by the National Automotive Technicians' Association. Some components of this test seem appropriate for testing time-consuming tasks such as transmission assembly.

Three simulation units were found to be potentially useful in testing. One such unit focusing upon lighting and carburation is prepared and discussed later in this report. Two other units worth mentioning are (1) the Snap-On ignition system simulator, which will allow for the wiring-in of various deficiencies to be located and repaired by the student; and (2) the Clayton Company motor unit, which is prewired to allow the wiring-in of engine problems to be located and repaired by the student. Both units allow for the testing of several diagnostic and replacement skills with instructor control and with a high degree of realism. Costs of both units

seem excessive, however ($488 for the Snap-On unit and $6800 for the Clayton unit, which includes a Falcon engine). A total set of test equipment and the optional units as described in the following sections would cost less than these two units.

Following the search for existing tests and after attempting to begin with the objectives, a move was made toward standard mechanics tasks as a beginning point for test development. Using one standard task as a test item, a unit of equipment could be constructed upon which the task could be completed. This change of structure eased the concerns of the test development team regarding lack of equipment on which to test, and served as an organizational device which prevented the problem of related objectives from interfering with the description of test-like events.

Once a series of test-like events had been described, testing equipment could be designed upon which the events could be made to occur. In discussing each of these events, grading procedures using color-coding for parts replacement and Polaroid pictures as event records were developed for a large percentage of the synthesized objectives. The synthesized objectives were then compared to the test events, and a surprising one-to-one relationship was found to be possible, allowing the test events to be used within the ESCOE system.

Only a few of the synthesized objectives could not be testing through this format. The untested objectives fell into the area of assembly or disassembly of motors or transmissions (because of the time required and the equipment needed), the area of parts replacement where parts removal results in the destruction of an expensive automobile component (such as the replacement of a muffler), and the area of parts repair requiring mal-

functions which cannot be built into parts without affecting the entire vehicle.

Test Unit Materials

Parallel to the basic ESCOE philosophy that the behavioral objectives developed by individual area teachers will have more instructional validity, the test developers feel that a similar philosophy should operate in automobile mechanics. In order to preserve this instructional validity, it is recommended that the students be tested in the shop in which they were taught, upon the same equipment on which they were taught, and on models very similar to those used in their instruction. The developers agree that transfer is hoped for, but care must be taken that the test events described are fair to each program.

Therefore, along these philosophical lines and along some operational lines not yet discussed, it is recommended that each school build its own set of test equipment and optional testing units as described. This recommendation is based upon concern for operational hazards and upon cost considerations. If either students or test equipment had to be moved to a testing site other than their own shop, the system would be required to tolerate a large variance in testing times or test center deviations from instructionsal settings. Costs of moving either students or equipment would be a continuing expense and would eventually become prohibitive.

Additional advantages can be gained from the construction of such units in that they can be used for instruction. Testing can be scheduled over the local shop such that it would not become reactive. Manufacturers' equipment most appropriate to the instructional goals can be used by the LEA, prevent-

ing an additional testing bias.

Both the chassis unit and the brake unit would cost less than $1,000.00. Two additional chassis units with increased options could raise equipment cost to $3,000.

Test units described in later pages represent the basic units upon which the test events have been prepared. The brake unit has standard shoes and a double cylinder. Optional units could be designed in a similar manner and might include: disc brakes, self-adjusting brakes, power brakes, and other options based upon different types of braking systems. Chassis options include an eight instead of six-cylinder engine, automatic transmission instead of standard, a four-barrel carburetor rather than standard, and similar alternatives.

The primary test chassis is described in the following pages.

TEST CHASSIS

Base Vehicle

1965-68 Chevrolet, 283 C.I. engine, standard transmission.

The general popularity of this vehicle makes it a reasonable candidate to be used as a test vehicle, both from the standpoint of its educational qualities and by virtue of its availability. However, there is no implication intended that this selection be imperative.

Body

It is suggested that the major portion of the body be removed to provide unhindered access to the various mechanical assemblies on which testing may be performed. Essentially, only the cowling portion will remain.

Chassis

Some components of the chassis could be modified by installing assemblies from other manufacturer brands of vehicles, thus adding to its tesing versatility.

Conversion Plans - Body

1. Remove all doors and hinges, seats, carpets, windshield, hood, front fenders, and grill. Radiator shell should remain in place (save headlamps).

2. Remove fuel tank and save for later replacement.

3. Pull rear lamp wiring harness through body from rear towards front and protect at cowling area for reinstallation.

4. Remove body mount bolts except those supporting cowling and radiator shell.

5. Cut roof supports at windshield opening level with dash.

6. Cut floor at toe-board joint area across full width of body.

7. Lift loose body unit from vehicle.

Conversion Plans - Chassis

1. Clean complete unit by appropriate means to remove oil and grease deposits.

2. Remove rust and scales from complete unit (scraper, wire brush, sandpaper, sand blast, etc.)

3. Convert one rear brake to Plymouth:

a. Modify backing plate by redrilling mounting holes as needed.

b. Modifications to drum include relocating lug bolt holes to fit existing lugs in axle flange and cutting away portion of outer wall of drum to permit view of internal parts.

4. Fabricate metal braces for supporting fuel tank.

5. Fabricate braces to support radiator shell.

6. Mount headlamps onto existing radiator shell and bracing.

7. Heat from welding torch can be applied to front coil springs to lower the vehicle.

8. Paint entire chassis in various colors so that color-coding may be effected.

9. Fabricate bracing for installation of taillamps.

10. Install wiring harness to connect headlamps and taillamps.

11. Fabricate bracing for installation of seats.

OPTIONAL UNITS

Several optional test units can be used to expand the capability of the basic units without the construction of optional chassis units. The optional subtest units are the following: (1) the lighting board, which contains typical circuitry; (2) the carburetor unit, which allows for wired-in carburetion problems; and (3) optional motors mounted on blocks.

BRAKE UNIT

The brake mockup unit available commercially provides a practical facility for learning as well as for testing various functions of this subject area. A similar unit can be easily constructed from used components (removed from vehicles which have been taken out of service) plus a few pieces of scrap iron.

The following construction directions are based on the popular Bendix self-adjusting brake design:

1. From a piece of 5" or 6" channel iron, fabricate a mount for the dual master cylinder and pedal assembly.

2. Next to this assembly on a board 2" x 10" x 2', fabricate a support to hold the front spindle, backing plate, and drum assembly.

3. Care should be taken to allow access to the adjusting hole if provided in backing plate.

4. Connect hydraulic lines. One line should be plugged, or attached to another type of brake unit on mockup unit--such as a disc brake.

Test Item Bank

Each of the test events for the automobile mechanics curriculum area is written in one-to-one correspondence with the synthesized objectives (except for those objectives which currently do not fit the testing design). These test events are described in the following format: (1) TEST ITEM--the task to be done; (2) UNIT SECTION--piece of test equipment on which the item is to be administered; (3) ACTUAL TASK--describes interactions which are to occur between tester and testee; (4) TIME--estimate of time required to complete the test task; (5) SCORING--detailed criteria to be observed by the classroom teacher; (6) RECORD--description of camera angles from which the completed task should be photographed for central scoring; and (7) RECORD SCORING--criteria instructions for the central scorer.

The automobile mechanics test item bank is presented in the following pages.

BLOCK 01 Power Train
UNIT 01 Engine

TEST ITEM:	Test cylinder compression, wet and dry.
UNIT SECTION:	Engine on chassis/stand.
ACTUAL TASK:	Both dry and wet cylinder tests must be performed, readings recorded.
TIME:	1 hour.
SCORING:	Instructor inspects 1) To see that all safety precautions are observed. 2) To see that readings are recorded correctly for dry test. 3) To see that wet test is performed correctly. 4) To see that readings are recorded correctly for wet test.
RECORD:	View of recorded test readings.
RECORD SCORING:	Recorded readings indicate compression tests, both wet and dry.

BLOCK 01 Power Train
UNIT 01 Engine

TEST ITEM:	Replace motor mounts.
UNIT SECTION:	Engine on chassis.
ACTUAL TASK:	Color-coded part must be installed to replace opposite color-coded part.
TIME:	2 hours.
SCORING:	Instructor inspects 1) To see that all safety precautions are observed. 2) To see that correct jacking procedures are used. 3) To see that all bolts are installed correctly and tightly.
RECORD:	1) View of left mount. 2) View of right mount.
RECORD SCORING:	Correct color-coded part has been installed. All bolts are installed correctly.

BLOCK 01 Power Train
UNIT 04 Clutch

TEST ITEM: Remove and replace clutch assembly.

UNIT SECTION: Engine on chassis.

ACTUAL TASK: Color-coded part must be installed to replace opposite color-coded part.

TIME: 2-3 hours.

SCORING: Instructor inspects
1) To see that all safety precautions are observed.
2) To see that correct jacking procedures are used.
3) Assembly bolts and mounting bolts for correct installation and tightness.
4) Clutch adjustments for correct free travel.
5) To see that transmission shifts correctly when clutch is depressed with engine running.

RECORD:
1) Top view showing installation of transmission.
2) Bottom view showing installation of clutch.

RECORD SCORING: Correct color-coded part has been installed. Correct installation of transmission.

BLOCK 01 Power Train
UNIT 06 Drive Line

TEST ITEM:	Replace universal joint.
UNIT SECTION:	Chassis.
ACTUAL TASK:	Color-coded part must be installed to replace opposite color-coded part.
TIME:	1-2 hours.
SCORING:	Instructor inspects 1) To see that all safety precautions are observed. 2) To see that new parts are installed correctly.
RECORD:	Top view of universal joint.
RECORD SCORING:	Correct color-coded part has been installed.

BLOCK 01 Power Train
UNIT 07 Cooling

TEST ITEM:	Pressure test cooling system.
UNIT SECTION:	Engine on chassis/stand.
ACTUAL TASK:	Using pressure testing equipment, pressure test must be performed on cooling system.
TIME:	1/2 hour.
SCORING:	Instructor inspects 1) To see that testing equipment is correctly used. 2) For correct reading of meter on testing equipment.
RECORD:	View of tester installed on cooling system.
RECORD SCORING:	Correct installation of tester. Scoring by instructor must be accepted.

BLOCK 01 Power Train
UNIT 07 Cooling

TEST ITEM: Replace radiator hoses.

UNIT SECTION: Engine on chassis/stand.

ACTUAL TASK: Color-coded parts must be installed to replace opposite color-coded parts.

TIME: 1 hour.

SCORING: Instructor

1) Inspects to see that hoses are installed correctly and that clamps are tightened properly.
2) Inspects to see that cooling system is refilled to the correct level.
3) Inspects to see that there are no leaks upon completion.
4) Operates engine until normal temperature is reached and inspects for proper circulation and absence of leaks.

RECORD: Top view showing both upper and lower hoses.

RECORD SCORING: Correct color-coded parts have been installed.

BLOCK 01 Power Train
UNIT 07 Cooling

TEST ITEM:	Replace core plugs.
UNIT SECTION:	Engine on chassis/stand.
ACTUAL TASK:	Color-coded parts must be installed to replace opposite color-coded parts.
TIME:	1-2 hours average, depending on engine.
SCORING:	Instructor 1) Inspects all core plugs for correct installation. 2) Inspects to see that all safety precautions are observed. 3) Inspects to see that system has no leaks. 4) Operates engine until normal temperature is reached to see that there are no leaks.
RECORD:	1) View of left side of engine showing all plugs. 2) View of right side of engine showing all plugs.
RECORD SCORING:	Correct color-coded parts have been installed.

BLOCK 01 Power Train
UNIT 07 Cooling

TEST ITEM: Replace water pump.

UNIT SECTION: Engine on chassis/stand.

ACTUAL TASK: Color-coded part must be installed to replace opposite color-coded part.

TIME: 1-2 hours.

SCORING: Instructor
1) Inspects all bolts for correct tightness.
2) Inspects pump for correct installation.
3) Inspects hose connection for correct installation and tightness.
4) Inspects cooling system level.
5) Operates engine until normal temperature is reached and inspects for any leaks which may develop.

RECORD: Top view showing pump and hoses.

RECORD SCORING: Correct color-coded part has been installed.

BLOCK 01 Power Train
UNIT 07 Cooling

TEST ITEM: Replace thermostat.

UNIT SECTION: Engine on chassis/stand.

ACTUAL TASK: Color-coded part must be installed to replace opposite color-coded part.

TIME: 1/2 - 1 hour.

SCORING: Instructor

1) Inspects to see that old gasket material is removed completely.
2) Inspects to see that thermostat is installed correctly.
3) Inspects thermostat housing bolts for correct installation and tightness.
4) Inspects hose connections for correct tightness.
5) Inspects to see that correct cooling system water level is maintained.
6) Operates engine to see that normal engine temperature is maintained.

RECORD:

1) View with thermostat housing removed showing installation of thermostat.
2) View of completely assembled cooling system showing thermostat housing and hose connections.

RECORD SCORING: Color-coded part has been correctly installed.

BLOCK 01 Power Train
UNIT 07 Cooling

TEST ITEM:	Remove and replace fan belt.
UNIT SECTION:	Engine on chassis/stand.
ACTUAL TASK:	Color-coded part must be installed to replace opposite color-coded part.
TIME:	1/2 hour.
SCORING:	Instructor inspects 1) Bolts for correct tightness. 2) Belt for correct tightness.
RECORD:	View from top showing installation of fan belt.
RECORD SCORING:	Color-coded part has been correctly installed.

BLOCK 02 Fuel and Exhaust
UNIT 02 Fuel Delivery

TEST ITEM: Replace fuel pump.

UNIT SECTION: Engine on chassis/stand.

ACTUAL TASK: Color-coded part must be installed to replace opposite color-coded part.

TIME: 1 hour.

SCORING: Instructor inspects
1) To see that all safety precautions are observed.
2) To see that new pump is installed correctly and that all fittings are tightened properly.
3) For any fuel leaks.
4) To see that engine runs properly.

RECORD: View of new pump showing all bolts and connections.

RECORD SCORING: Color-coded part has been correctly installed.

BLOCK 02 Fuel and Exhaust
UNIT 02 Fuel Delivery

TEST ITEM:	Remove and replace fuel filter.
UNIT SECTION:	Engine on chassis/stand.
ACTUAL TASK:	Color-coded part must be installed to replace opposite color-coded part.
TIME:	1/2 hour.
SCORING:	Instructor inspects 1) To see that all safety precautions are observed. 2) To see that filter is installed properly. 3) To see that there are no fuel leaks.
RECORD:	View of filter showing all connections.
RECORD SCORING:	Color-coded part has been correctly installed.

BLOCK 02 Fuel and Exhaust
UNIT 02 Fuel Delivery

TEST ITEM:	Remove, test, and replace air cleaner.
UNIT SECTION:	Engine on chassis/stand.
ACTUAL TASK:	Color-coded part must be installed to replace opposite color-coded part.
TIME:	1/2 hour.
SCORING:	Instructor inspects 1) To see that correct test is made using light bulb. 2) To see that new filter is installed correctly.
RECORD:	Top view of new filter (air cleaner cover removed).
RECORD SCORING:	Color-coded part has been correctly installed.

BLOCK 02 Fuel and Exhaust
UNIT 02 Fuel Delivery

TEST ITEM:	Replace intake manifold gaskets.
UNIT SECTION:	Engine on chassis/stand.
ACTUAL TASK:	New gaskets must be installed.
TIME:	1-2 hours.
SCORING:	Instructor 1) Inspects to see that all safety precautions are observed. 2) Inspects for correct installation of manifold. 3) Inspects for correct torquing of bolts. 4) Inspects for any water or vacuum leaks. 5) Operates engine for smooth running performance.
RECORD:	Top view of engine showing manifold, all bolts and connections.
RECORD SCORING:	New parts have been installed and verified by instructor.

BLOCK 03 Electrical
UNIT 01 Ignition

TEST ITEM:	Remove, gap, and replace spark plugs.
UNIT SECTION:	Engine on chassis/stand.
ACTUAL TASK:	Color-coded parts must be installed to replace opposite color-coded parts.
TIME:	Dependent upon engine type (1965-70 Chevrolet V-8: 1-2 hours).
SCORING:	Instructor inspects 1) Plug gaps. 2) Tightness of installed plugs. 3) Correct location of wires. 4) To see that engine operates smoothly.
RECORD:	1) View of plugs showing position of wires. 2) View of oscilloscope screen.
RECORD SCORING:	Color-coded parts have been correctly installed. Oscilloscope screen shows normal spike lines.

BLOCK 03 Electrical
UNIT 01 Ignition

TEST ITEM:	Replace "open" spark plug wire.
UNIT SECTION:	Engine on chassis/stand.
ACTUAL TASK:	Using oscilloscope, defective part must be loct ed, removed, and replaced with new color-coded part.
TIME:	1 hour.
SCORING:	Instructor 1) Performs inspection for correct connection of oscilloscope. 2) Performs inspection for correct installation of replaced spark plug wire. 3) Observes oscilloscope screen for normal firing lines. 4) Inspects to see that engine runs smoothly.
RECORD:	1) Top view showing all spark plug wires. 2) View of oscilloscope screen.
RECORD SCORING:	Color-coded part has been correctly installed. Oscilloscope screen shows normal firing lines.

BLOCK 03 Electrical
UNIT 01 Ignition

TEST ITEM: Remove and replace distributor points and condenser.

UNIT SECTION: Engine on chassis/stand.

ACTUAL TASK: Color-coded part must be installed to replace opposite color-coded part.

TIME: 1 hour.

SCORING: Instructor performs
1) Inspection of distributor for correct location of parts.
2) Observation of dwell meter for correct reading.

RECORD:
1) View of open distributor.
2) View of distributor showing distributor cap.
3) View of dwell meter reading.

RECORD SCORING: Color-coded part has been correct installed. Dwell meter reading is correct.

BLOCK 02 Electrical
UNIT 01 Ignition

TEST ITEM:	Replace distributor cap.
UNIT SECTION:	Engine on chassis/stand.
ACTUAL TASK:	Color-coded part must be installed to replace opposite color-coded part.
TIME:	1 hour.
SCORING:	Instructor performs 1) Inspection of all wires for correct connections into cap. 2) Observation of engine for smooth running performance.
RECORD:	Top view showing all wire connections.
RECORD SCORING:	Color-coded part has been correctly installed.

BLOCK 03 Electrical
UNIT 01 Ignition

TEST ITEM: Test and replace ignition coil.

UNIT SECTION: Engine on chassis/stand.

ACTUAL TASK: Color-coded part must be installed to replace opposite color-coded part.

TIME: 1 hour.

SCORING: Instructor
1) Inspects to see that correct tester connections are completed.
2) Observes coil tester for correct reading.
3) Inspects to see that new coil is installed properly.
4) Operates engine for correct running performance.

RECORD:
1) View of coil tester showing readings.
2) View of coil connection.

RECORD SCORING: Color-coded part has been correctly installed.
Coil tester readings are correct.

BLOCK 03 Electrical
UNIT 04 Charging

TEST ITEM:	Test output of generator.
UNIT SECTION:	Engine on chassis/stand.
ACTUAL TASK:	Proper test procedure must be followed and correct readings must be recorded.
TIME:	1 hour.
SCORING:	Instructor inspects 1) All meter connections for correct location. 2) Test procedure for proper sequence. 3) Meter reading for proper recording.
RECORD:	View of meter showing all connections and readings.
RECORD SCORING:	All meter readings properly recorded.

BLOCK 03 Electrical
UNIT 04 Charging

TEST ITEM: Remove and replace generator.

UNIT SECTION: Engine on chassis/stand.

ACTUAL TASK: Color-coded part must be installed to replace opposite color-coded part.

TIME: 1/2 hour.

SCORING: Instructor inspects
1) To see that all safety precautions are observed.
2) To see that all wires are connected properly.
3) All mounting and adjusting bolts for correct installation.
4) Fan belt tightness.
5) To see that charging system operates properly with engine running.

RECORD:
1) View of generator.
2) View of deflected fan belt.

RECORD SCORING: Color-coded part has been correctly installed. Fan belt shows correct tension.

BLOCK 03 Electrical
UNIT 04 Charging

TEST ITEM: Turn commutator on lathe.

UNIT SECTION: Individual armature.

ACTUAL TASK: Red score on commutator must be removed, but blue marking in groove which shows maximum depth must remain.

TIME: 1 hour.

SCORING: Instructor inspects
1) To see that armature is installed in lathe correctly.
2) To see that red groove is removed and commutator is left with a smooth finish.
3) To see that blue maximum depth groove is still visible.
4) To see that commutator is undercut correctly.

RECORD:
1) View of armature mounted in lathe.
2) View of commutator at completion of undercutting.

RECORD SCORING: Only blue proove remains visible on commutator. Commutator has smooth finish.

BLOCK 03 Electrical
UNIT 05 Starting

TEST ITEM: Replace starter drive--on engine.

UNIT SECTION: Engine on chassis/stand.

ACTUAL TASK: Color-coded part must be installed to replace opposite color-coded part.

TIME: Dependent upon engine type (1965-70 Chevrolet: 1-2 hours).

SCORING: Instructor inspects
1) Armature for correct location of drive parts.
2) Assembled starter for correct assembly.
3) Performance of starter during bench test.
4) Starter mounted on engine to see that mounting is correct and all wires are connected properly.
5) To see that engine starts properly.

RECORD:
1) View of armature showing all drive parts.
2) View of assembled starter.
3) View of starter mounted on engine.

RECORD SCORING: Color-coded part has been correctly installed. All housings bolted correctly on assembled starter; all bolts and wires located correctly on starter mounted on engine.

BLOCK 04 Chassis and Body
UNIT 01 Front Suspension

TEST ITEM:	Replace front end stabilizer links.
UNIT SECTION:	Test chassis.
ACTUAL TASK:	Color-coded part must be installed to replace opposite color-coded part.
TIME:	1 hour.
SCORING:	Instructor inspects 1) To see that safe jacking procedures are used. 2) To see that all parts are installed correctly.
RECORD:	Front view showing all parts of stabilizer links.
RECORD SCORING:	Color-coded part has been correctly installed.

BLOCK 04 Chassis and Body
UNIT 01 Front Suspension

TEST ITEM:	Replace lower ball joints.
UNIT SECTION:	Test chassis.
ACTUAL TASK:	Color-coded parts must be installed to replace opposite color-coded parts.
TIME:	2-3 hours.
SCORING:	Instructor 1) Inspects to see that safe jacking procedures are used. 2) Inspects to see that all parts are installed correctly and that bolts are tightened properly. 3) Road tests vehicle for proper operation.
RECORD:	Front view showing installation of new parts.
RECORD SCORING:	Color-coded parts have been correctly installed. Road test indicates proper operation of vehicle.

BLOCK 04 Chassis and Body
UNIT 01 Front Suspension

TEST ITEM:	Replace tie rod ends.
UNIT SECTION:	Test chassis.
ACTUAL TASK:	Color-coded parts must be installed to replace opposite color-coded parts.
TIME:	1-2 hours.
SCORING:	Instructor inspects 1) To see that safe jacking procedures are used. 2) To see that all parts are correctly installed. 3) To see that correct toe-in adjustment has been performed.
RECORD:	View of tie rod.
RECORD SCORING:	Color-coded parts have been correctly installed.

BLOCK 04 Chassis and Body
UNIT 01 Front Suspension

TEST ITEM:	Repack front wheel bearings.
UNIT SECTION:	Test chassis/brake mockup.
ACTUAL TASK:	Wheel bearings must be removed, cleaned, and repacked with new lubricant.
TIME:	1 hour.
SCORING:	Instructor inspects 1) To see that all parts are thoroughly cleaned. 2) To see that parts are repacked with lubricant properly. 3) To see that parts are properly installed. 4) For proper adjustment procedures.
RECORD:	1) View of parts removed from drum. 2) View of cleaned parts. 3) View of parts replaced into drum. 4) View of adjusting nuts and cotterpin installation.
RECORD SCORING:	Parts removed have been cleaned and replaced. Adjustments are correct; instructor verification.

BLOCK 04 Chassis and Body
UNIT 01 Front Suspension

TEST ITEM:	Adjust front wheel bearings.
UNIT SECTION:	Brake mockup/test chassis.
ACTUAL TASK:	Adjusting nut might be tightened to proper indicator mark.
TIME:	1/2 hour.
SCORING:	Instructor inspects 1) For correct location of adjusting nut. 2) For correct installation of cotterpin.
RECORD:	View of adjusting nut and cotterpin.
RECORD SCORING:	Red line on adjusting nut is vertical, yellow line is horizontal. Cotterpin installed and cut properly.

BLOCK 04 Chassis and Body
UNIT 02 Rear Suspension

TEST ITEM: Replace front shock absorbers.

UNIT SECTION: Test chassis.

ACTUAL TASK: Color-coded parts must be installed to replace opposite color-coded parts.

TIME: 1-2 hours.

SCORING: Instructor
1) Inspects to see that proper jacking procedures are used.
2) Inspects to see that all new parts are correctly installed.
3) Road tests vehicle for proper operation.

RECORD:
1) View through coil springs showing new parts.
2) Top view showing upper bushings and retaining nuts and washers.
3) Bottom view showing lower bushings and retaining nuts and washers.

RECORD SCORING: Color-coded parts have been correctly installed.

BLOCK 04 Chassis and Body
UNIT 02 Rear Suspension

TEST ITEM:	Replace rear spring shackles.
UNIT SECTION:	Test chassis.
ACTUAL TASK:	Color-coded parts must be installed to replace opposite color-coded parts.
TIME:	1-2 hours.
SCORING:	Instructor 1) Inspects to see that correct jacking procedures are used. 2) Inspects to see that new parts are correctly installed. 3) Road tests vehicle for proper operation.
RECORD:	View of shackles showing installation of new parts.
RECORD SCORING:	Color-coded parts have been correctly installed.

BLOCK 04 Chassis and Body
UNIT 04 Steering (Standard)

TEST ITEM:	Replace steering gear.
UNIT SECTION:	Test chassis.
ACTUAL TASK:	Color-coded part must be installed to replace opposite color-coded part.
TIME:	3 hours.
SCORING:	Instructor 1) Inspects to see that safe procedures are used. 2) Inspects to see that Pitman arm puller is used correctly. 3) Inspects to see that new steering gear is installed correctly. 4) Road tests vehicle for correct operation.
RECORD:	1) Top view showing steering gear installation. 2) Bottom view showing Pitman arm and linkage.
RECORD SCORING:	Color-coded part has been correctly installed.

BLOCK 04 Chassis and Body
UNIT 07 Lubrication

TEST ITEM:	Lubricate chassis.
UNIT SECTION:	Test chassis.
ACTUAL TASK:	All lubrication points must be lubricated.
TIME:	1/2 hour.
SCORING:	Instructor inspects 1) To see that all fittings are properly lubricated. 2) For proper use and care of lubrication equipment.
RECORD:	Instructor verifies proper lubrication procedures and completion.
RECORD SCORING:	Instructor verification.

BLOCK 04 Chassis and Body
UNIT 07 Lubrication

TEST ITEM: Raise car on lift.

UNIT SECTION: Test chassis.

ACTUAL TASK: Test chassis must be properly raised on lift.

TIME: 1/2 hour.

SCORING: Instructor inspects
1) To see that vehicle is located properly over lift.
2) To see that safety precautions are observed in use of lift.
3) To see that vehicle is lifted completely and safely.

RECORD:
1) Front view under vehicle showing contact of lift to vehicle.
2) Rear view under vehicle showing contact of lift to vehicle.

RECORD SCORING: Proper contact to lift to vehicle; vehicle has been lifted properly.

BLOCK 04 Chassis and Body
UNIT 07 Lubrication

TEST ITEM: Replace oil filter.

UNIT SECTION: Test chassis.

ACTUAL TASK: Color-coded part must be installed to replace opposite color-coded part.

TIME: 1/2 hour.

SCORING: Instructor
1) Inspects to see that special tools are properly utilized.
2) Inspects to see that gasket surfaces are cleaned properly.
3) Inspects to see that new filter is installed and tightened properly.
4) Operates vehicle to test for correct oil pressure and to inspect for leaks.
5) Inspects to see that proper oil level is maintained.

RECORD: Top view showing installation of new oil filter.

RECORD SCORING: Color-coded part has been correctly installed.

BLOCK 04 Chassis and Body
UNIT 09 Tires

TEST ITEM: Repair inner tube.

UNIT SECTION: Test chassis.

ACTUAL TASK: Tire must be removed, repaired, and replaced.

TIME: 1 hour.

SCORING: Instructor inspects
1) To see that proper vehicle jacking is used.
2) To see that tire is removed properly from wheel.
3) To verify puncture in inner tube.
4) To see that new patch is applied correctly.
5) To see that new patch does not leak air pressure.
6) To see that tire and tube are assembled onto wheel properly and that correct air pressure is maintained.
7) To see that tire is replaced onto wheel and tightened properly.

RECORD:
1) View of puncture wound on inner tube.
2) View of patch installed over puncture on inner tube.
3) View of fully inflated tire replaced on test chassis.

RECORD SCORING: New patch has been correctly installed on inner tube, wheel replaced on test chassis. Instructor verification.

BLOCK 04 Chassis and Body
UNIT 09 Tires

TEST ITEM:	Replace tire valve assembly.
UNIT SECTION:	Wheel from test chassis.
ACTUAL TASK:	Color-coded part must be installed to replace opposite color-coded part.
TIME:	1/2 hour.
SCORING:	Instructor inspects 1) To see that tire is separated from wheel properly. 2) To see that old part is removed properly. 3) To see that new part is installed properly. 4) To see that tire is inflated properly.
RECORD:	Top view of wheel showing installation of new part.
RECORD SCORING:	Color-coded part has been correctly installed.

BLOCK 04 Chassis and Body
UNIT 09 Tires

TEST ITEM: Rotate four wheels.

UNIT SECTION: Test chassis.

ACTUAL TASK: Number-coded parts must be exchanged for opposite number-coded parts.

TIME: 1 hour.

SCORING: Instructor inspects
1) To see that proper jacking procedures are used.
2) To see that number-coded parts are replaced in location by opposite number-coded parts.
3) To see that parts are installed and tightened properly.

RECORD:
1) View of left side of chassis.
2) View of right side of chassis.

RECORD SCORING: Number-coded parts have been installed in correct location.

BLOCK 04 Chassis and Body
UNIT 09 Tires

TEST ITEM:	Balance wheels, off of test chassis.
UNIT SECTION:	Wheels from test chassis.
ACTUAL TASK:	Balance weights must be installed in proper location.
TIME:	1/2 hour.
SCORING:	Instructor inspects to see that proper weights are installed in proper location.
RECORD:	Top view of wheel showing installation of weights.
RECORD SCORING:	Weights have been correctly installed.

BLOCK 04 Chassis and Body
UNIT 11 Wheel Bearings (Rear)

TEST ITEM: Replace rear axle bearings.

UNIT SECTION: Test chassis.

ACTUAL TASK: Color-coded part must be installed to replace opposite color-coded part.

TIME: 1-2 hours.

SCORING: Instructor

1) Inspects to see that proper jacking procedures are used.
2) Inspects to see that proper removal of axle is performed.
3) Inspects to see that removed axle is installed in hydraulic press properly and that pressing is done correctly.
4) Inspects to see that new bearing is pressed onto axle correctly.
5) Inspects to see that axle is replaced correctly.
6) Road tests vehicle for proper operation.

RECORD: View of removed axle showing installation of new parts.

RECORD SCORING: Color-coded parts have been correctly installed. Instructor verification.

BLOCK 04 Chassis and Body
UNIT 14 Brakes

TEST ITEM:	Replace hydraulic brake tubing.
UNIT SECTION:	Test chassis.
ACTUAL TASK:	Color-coded part must be installed to replace opposite color-coded part.
TIME:	1 hour.
SCORING:	Instructor 1) Inspects to see that new line is flared correctly. 2) Inspects to see that new part is installed and tightened properly. 3) Tests for leaks.
RECORD:	1) View showing removed brake tubing with new flare applied. 2) View of replaced tubing on chassis.
RECORD SCORING:	Color-coded part has been correctly installed.

BLOCK 04 Chassis and Body
UNIT 13 Brakes (Disc)

TEST ITEM: Replace pads on front disc brakes.

UNIT SECTION: Test chassis (optional).

ACTUAL TASK: Color-coded parts must be installed to replace opposite color-coded parts.

TIME: 1 hour.

SCORING: Instructor

1) Inspects to see that proper jacking procedures are used.
2) Inspects to see that old parts are removed properly.
3) Inspects to see that new parts are installed correctly and that all retaining pins and clips are in place.
4) Inspects to see that wheel is replaced correctly.
5) Road tests vehicle for correct operation.

RECORD: View of disc brake assembly showing installation of new parts.

RECORD SCORING: Color-coded parts have been correctly installed.

BLOCK 04 Chassis and Body
UNIT 14 Brakes

TEST ITEM:	Replace brake shoes.
UNIT SECTION:	Brake mockup.
ACTUAL TASK:	Color-coded parts must be installed to replace opposite color-coded parts.
TIME:	1/2 hour - 1-1/2 hours.
SCORING:	Instructor inspects 1) Brake shoe parts to see that all parts are installed correctly. 2) Brake pedal to see that pedal height is above accepted indicator line.
RECORD:	1) Front view through open drum showing installation of new brake shoes. 2) View of depressed pedal.
RECORD SCORING:	Color-coded parts have been correctly installed. Depressed pedal above accepted indicator line.

BLOCK 04 Chassis and Body
UNIT 14 Brakes

TEST ITEM:	Adjust and bleed brakes.
UNIT SECTION:	Brake mockup.
ACTUAL TASK:	Brake pedal below accepted indicator line when depressed must be returned so that depressed pedal is above accepted indicator line.
TIME:	1/2 hour.
SCORING:	Instructor inspects 1) To see that master cylinder is full of fluid. 2) To see that depressed brake pedal is above accepted indicator line.
RECORD:	View of depressed brake pedal.
RECORD SCORING:	Pedal heigh is above accepted indicator line.

BLOCK 04 Chassis and Body
UNIT 14 Brakes

TEST ITEM:	Turn brake drum on lathe.
UNIT SECTION:	Brake mockup.
ACTUAL TASK:	Red score on drum must be removed, but blue marking in groove which shows maximum depth of .060" must remain.
TIME:	1 hour.
SCORING:	Instructor inspects 1) Drum to see that red groove is removed and that drum is left with a smooth finish. 2) To see that blue maximum depth groove is still visible. 3) To see that all safety precautions are observed while operating lathe.
RECORD:	View of inside of drum.
RECORD SCORING:	Red groove has been removed and blue groove is still visible.

BLOCK 04 Chassis and Body
UNIT 14 Brakes

TEST ITEM: Replace master cylinder.

UNIT SECTION: Brake mockup/test chassis.

ACTUAL TASK: Color-coded part must be installed to replace opposite color-coded part.

TIME: 1 hour.

SCORING: Instructor inspects
1) All connections and mounting bolts.
2) To see that master cylinder is full of fluid.
3) Toe board clearance, which should be 1/4 to 3/8 inch.
4) Depressed brake pedal to see that height of pedal is above accepted indicator line.

RECORD:
1) Top view of cylinder showing all connections and mounting bolts.
2) View of partially depressed pedal.
3) View of fully depressed pedal.
4) View of open master cylinder.

RECORD SCORING: Color-coded part has been correctly installed. Partially depressed pedal shows proper toe board clearance; fully depressed pedal shows height of pedal above accepted indicator line. Open master cylinder indicates fluid level at full mark.

BLOCK 04 Chassis and Body
UNIT 14 Brakes

TEST ITEM:	Replace wheel cylinder, bleed line.
UNIT SECTION:	Brake mockup.
ACTUAL TASK:	Color-coded part must be installed to replace opposite color-coded part.
TIME:	1 hour - 1-1/2 hours.
SCORING:	Instructor inspects 1) To see that all brake shoe parts are installed correctly. 2) To see that wheel cylinder and tubing are installed correctly. 3) To see that master cylinder is full of fluid. 4) To see that depressed brake pedal height is above accepted indicator line.
RECORD:	1) View of front through open drum showing related brake shoe parts. 2) Top view showing wheel cylinder bolts and tubing. 3) View of depressed brake pedal.
RECORD SCORING:	Color-coded part has been correctly installed. Depressed brake pedal is above accepted indicator line.

BLOCK 05 Basic Equipment and Tools
UNIT 01 Jacking

TEST ITEM: Support vehicle on jack stand.

UNIT SECTION: Test chassis.

ACTUAL TASK: Chassis must be lifted and supported correctly on four jack stands.

TIME: 1/2 hour.

SCORING: Instructor inspects
1) To see that vehicle is lifted by correct jacking points.
2) To see that jack stands are positioned correctly under both front and rear of chassis.
3) To see that vehicle is positioned correctly and safely on jack stands.

RECORD:
1) View of front jack stands from under chassis.
2) View of rear jack stands from under chassis.

RECORD SCORING: Jack stands are in correct position.

Administration and Scoring Procedures

Perhaps the most lucid way in which to describe the administration and scoring procedures developed for the automobile mechanics test area is by example. The test material is actually a matrix of test items arranged in one-to-one correspondence to the behavioral objectives used in the ESCOE system to describe the curriculum. The classroom instructor identifies the objectives upon which he wishes to test his class. Depending upon whether the test is being used for diagnostic purposes regarding competency of an individual student or for curriculum or instructional analysis of the entire class, items parallel to the identified objectives are chosen from the test matrix and assigned to students.

For student diagnosis, one student may be asked to spend a week (approximately 30 hours) taking the entire battery for a particular level of the curriculum. For instructional analysis, several students may be asked to take only a few items ranging across the total curriculum and requiring only one or two days (four to ten hours). Regardless of the purpose of testing, it is assumed that the test will be administered on school-owned equipment and that this equipment will be selected for its similarity to equipment upon which the students have been instructed.

To illustrate the administration procedures, let us suppose that John Doe has been assigned the test item involving replacement of a master cylinder. This item could be performed on either of the proposed test equipment units (test chassis or brake mockup) or could be performed on one of the optional test units, depending upon the type of braking system to be tested. In this example let us assume that the brake mockup has been selected for

the test because the wheel bearing test item is being attempted on the test chassis and John is to demonstrate his skills on a standard braking system.

John is assigned the brake mockup, which has a red master cylinder and is equipped with a clear plastic drum so that the yellow brake shoes can be observed when the pedal is depressed. The unit has a range-marker which indicates to the student how much pedal depression should be allowed.

After John has checked the unit, he reports to his instructor and checks out the replacement cylinder, which is color-coded silver. John replaces the master cylinder, bleeds the lines, and tests the pedal. When he is satisfied, he returns the red-coded cylinder; the instructor records John's completion time and goes with John to inspect his job. He checks the connections and mounting bolts, checks the fluid in the cylinder, and depresses the brake pedal.

Two Polaroid pictures are taken of the unit with the brake pedal depressed. The first shot shows the color of the cylinder and the height of the pedal. If the pedal is depressed beyond the acceptable range, the student has failed to replace the cylinder properly. If the pedal cannot be depressed, too much fluid has been placed in the cylinder, potentially indicating an inadequate performance on the part of the student. The second Polaroid shot shows the same depressed pedal but focuses upon the shoes to indicate that they are working.

Thus the performance has been timed and graded as to adequacy in an objective, permanent record form. Most of the automobile mechanics test items are administered and scored in a similar manner.

Field Review and Recommendations

Due to the time limitations of the contract, the close of school, and the time required for construction of on-the-scene units, only field review rather than field testing was conducted. Time limitations also failed to allow for the construction of more than a simply illustrative unit; however, enough exploration was performed to assure the feasibility of constructing units such as those proposed in this report. Test subsections described to a group of five vocational educators received very satisfying acceptance.

Field testing should definitely be conducted--but only after several testing units are constructed.